How much CO_2 *do you* think will be in the atmosphere?

- … in 2100, if global emissions stay the same as today (no population increase or development)
  - Information needed (rounded):
  - Current world-wide emissions 10Gt carbon/yr
  - About 60% of the CO_2 remains in the atmosphere (the rest goes into the ocean and land)
  - There is 835Gt of carbon in the atmosphere today (394ppm)

10 Gt/yr * 0.6 = 6 Gt/yr stay in atmosphere
6 Gt/yr * 90 years = 540 Gt more carbon in 2100

Total C in atmosphere?
835 + 540 = 1370 Gt = 1375/2.12 ppm = 650 ppm
(2x preindustrial)

How much CO_2 *do you* think will in be the atmosphere?

- … in 2050, if everyone in the world lived life like an American?
  - 300M people live in the US and we emit 2Gt/yr (including land use)
  - 7B people in the world today, 9B by 2050
  - 60% of what is emitted stays in the atmosphere

The average world population over the next 40 years = 8B

Emission rate: 2 Gt/yr / 0.3B people x 8B people = 53 Gt/yr

Total carbon increase in 38years? 53 Gt/yr x 38 years = 2014 Gt

If 60% stays in atmosphere, then the carbon increase is
2014 * 0.6 = 1210 Gt

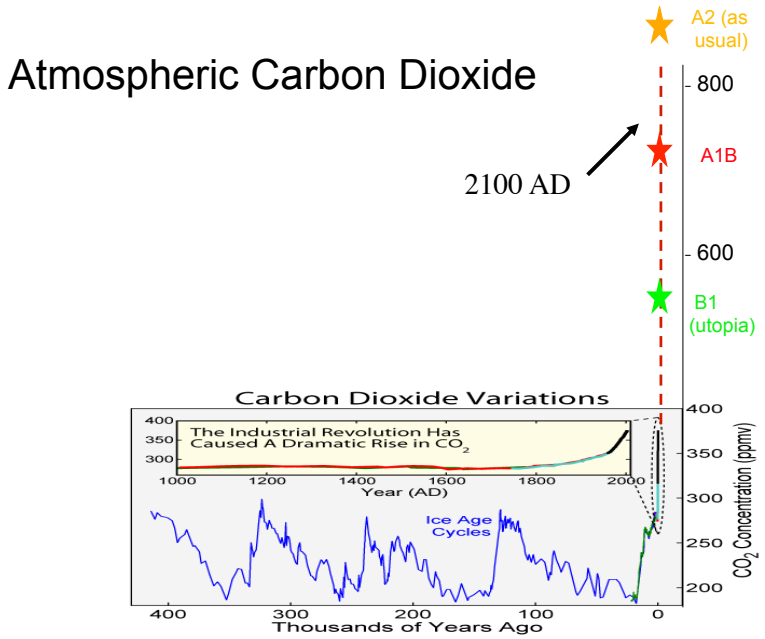
So the atmosphere CO2 concentration is (835 + 1210)Gt/2.12 Gt/ ppm = 965 ppm (3x preindustrial)!

How much CO_2 *do you* think will be in the atmosphere?

- If we wanted to stabilize CO_2 concentrations in the atmosphere, how much could the US emit fairly?
  - Information needed:
  - World emissions would must be less than 1Gt/yr

The fraction of the world's people living in the US = 0.3B/7B = 0.042

The fair share of emissions is thus 1Gt * 0.042 = 0.42 Gt/yr, or about 2% of what we now emit.



3. Projections of Climate Change: 2100 and beyond

- The projected forcings
- The projected climate change: 2000 to 2100
  - Global
  - Regional
  - Sea Level
  - Cryosphere
  - Extreme Events
- The long term outlook 2100 - 2300

Climate change due to increasing greenhouse gases

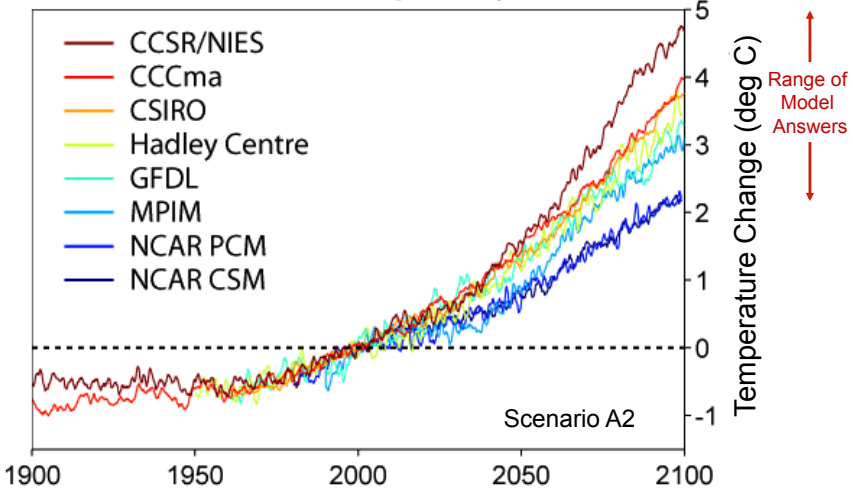
Changes that are *very likely** over the next 100 years include:

- the planet will warm, more so in middle and high latitudes than in the tropics
- the hydrologic cycle will speed up
- the area covered by snow and sea ice in winter will decrease
- the interior of continents will be drier in the summertime
- the sea level will rise
- the surface ocean will become 2-3 times more acidic

These changes will be ***much, much*** greater than the changes seen over the past 150 years that have been attributed to increased greenhouse gases and aerosols.

*Very likely** = greater than 90% chance

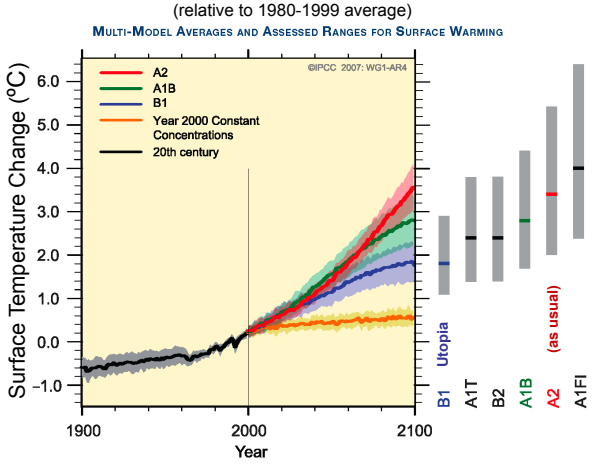
Global Warming Projections



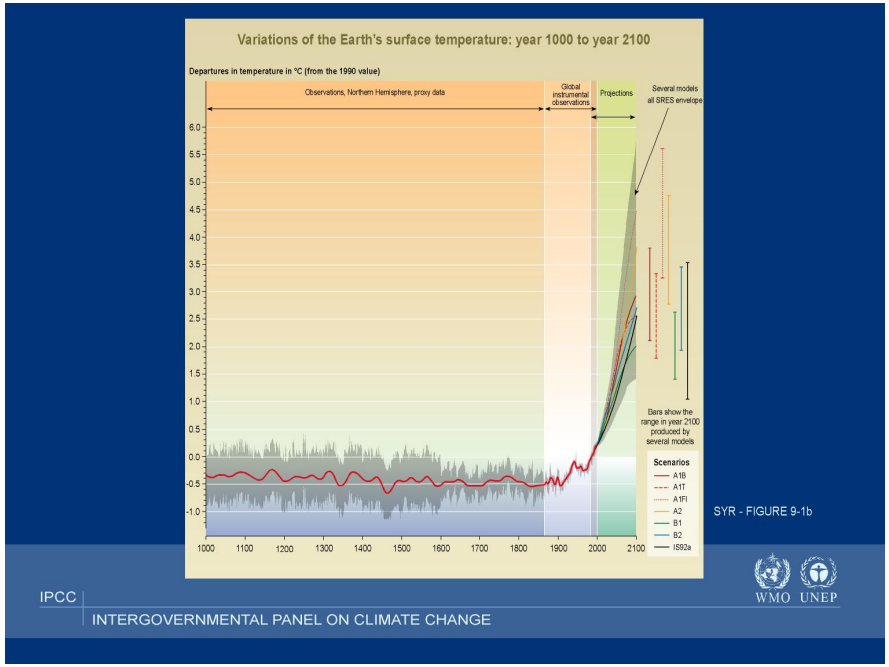
The range in projections is a measure of the uncertainty in the models, given a perfect emission forecast.

Global Average Temperature Change

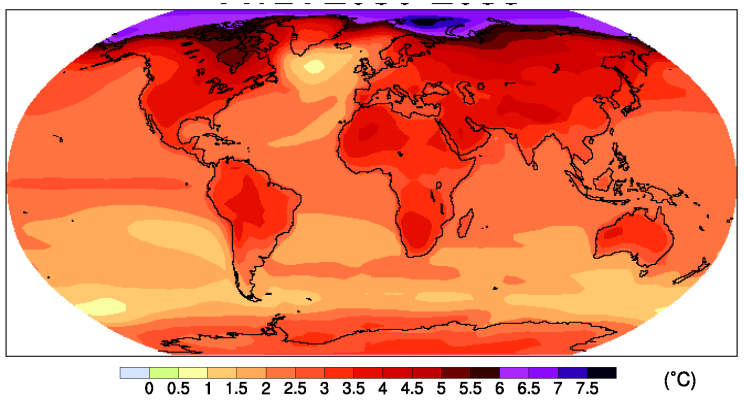
(relative to 1980-1999 average)



For a mid-range (A1B) emission scenario, model project an global average warming over the next 100 years of 2.8 ºC: 3 to 4 times the warming over the past century.

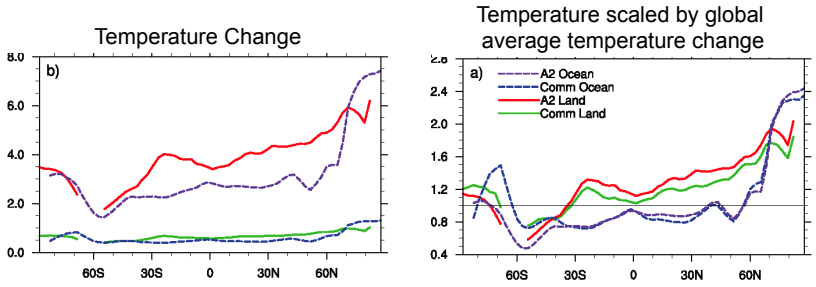


Projected Annual Average Surface Temperature Change:
"2080-2099" minus "1980-1999"



Average of 21 climate models forced by Scenario A1B.
Multiply by ~1.2 for A2 and ~0.7 for B1

Zonal (east-west) Temperature Changes: 2090 minus 1990



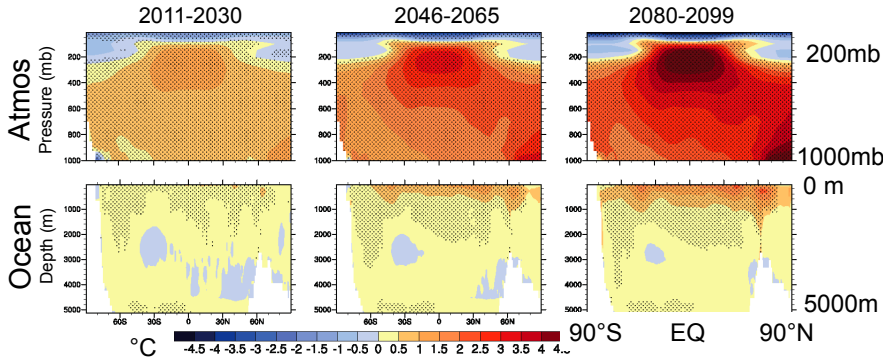
Average of 21 climate models forced by Scenario A2

- Land warms more than ocean
- High latitudes warm more than tropics
- "Land minus Ocean" and latitudinal amplification scale with the global average temperature change

Comm = commitment (don't worry about this)

IPCC AR4, Fig 10.6

Zonal (east-west) Temperature Changes: 2090 minus 1990 (scenario A1B)

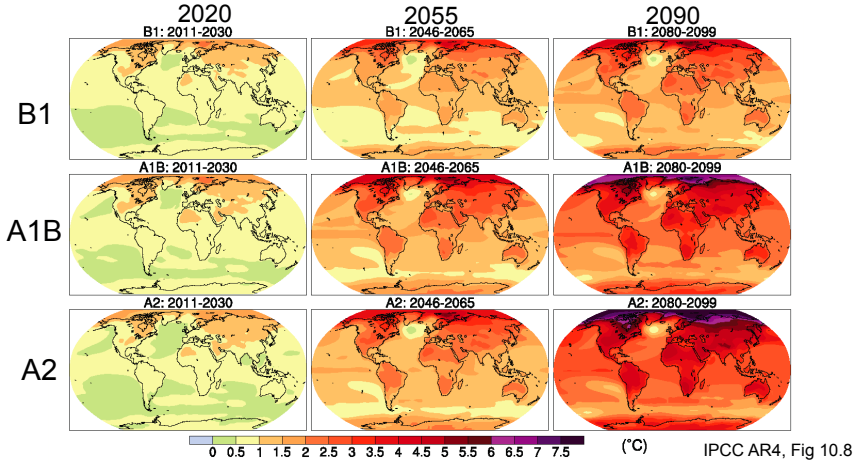


Warming throughout the atmosphere.

Warming in the surface ocean (top 200m), spreading downward over time; ~1000 years to reach bottom.

IPCC AR4, Fig 10.7

Projected Annual Average Surface Temperature Change:



IPCC AR4, Fig 10.8

Average of 17/21/21 climate models forced by Scenario A2/A1B/B1.

A2 is about 1.2 times A1B; B1 is about 0.7 times A1B